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RADIOLOGICAL HEALTH DATA

MONTHLY REPORT

April 1960

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

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PREFACE

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned, among other things, primary responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels. Within the Department this responsibility has been delegated to the Division of Radiological Health, Public Health Service.

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As a step in the discharge of this responsibility, the Public Health Service is initiating this monthly publication. The data have been submitted by agencies of the Federal government, by States, and by other sources. Each third report, starting July 1960 will contain interpretative statements as well as data.

The monthly and quarterly reports will be reviewed by a Board of Editorial Advisors with representatives from the following Federal agencies:

Department of Health, Education, and Welfare
Atomic Energy Commission
Department of Defense
Department of Commerce
Department of Agriculture

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SECTION I

INTERPRETATIONS OF RADIATION LEVELS

A usual procedure for establishing criteria of occupational exposure to ionizing radiation is to set a maximum permissible radiation dose to an organ or organs over a specified period of time. This dose is then used for establishing permissible external radiation levels and for calculating maximum permissible concentrations of radionuclides in water and air. The maximum permissible concentration (MPC) of a radionuclide in water and air is a concentration of that nuclide which would, by itself, result in the maximum permissible personnel exposure if ingested or inhaled over the specified time. Obviously such calculations of MPC's require the use of many assumptions which are based on the best current information. As newer and better information and interpretations are developed, better estimates and calculations may be made of doses to the body resulting from given environmental contamination levels. However, the basic criterion remains that of permissible radiation doses to the body.

The concept of maximum permissible concentrations of radionuclides in water and air was developed initially for atomic energy workers. By applying certain conversion factors it has been used in the past for the general population. The table below summarizes the maximum permissible concentrations for some single radionuclides in water and air as applied to occupational exposures.

National Committee on Radiation Protection and Measurements (NCRP)

In the release (April 23, 1959) accompanying the issuance of recommendations on maximum permissible amounts of radionuclides in the human body and maximum permissible concentrations in air and water (National Bureau of Standards Handbook 69), it was stated* by the National Committee on Radiation Protection:

> "... Exposure of the whole population to natural and man-made sources of radiation presents a different problem and involves many factors beyond technical control. The NCRP reports, thus far, contain recommendations only on matters that are subject to control. The recommended values for MPD's and MPC's apply specifically only to occupational conditions and in the neighborhood of controlled

*The full statement may be found in "National Committee on Radiation Protection and Measurements (NCRP), Summary of NBS Handbook 69." The American Journal of Roentgenology, Radium Therapy and Nuclear Medicine, Vol. 82, No. 2, Aug. 1959, p. 342-345.

TABLE I. MAXIMUM PERMISSIBLE CONCENTRATIONS FOR RADIONUCLIDES IN WATER AND IN AIR FOR OCCUPATIONAL EXPOSURE[a]

	NCRP				ICRP[b]	
	Handbook #52		Handbook #69 (Superseding #52)		Water[c]	Air[d]
	Water[c]	Air[d]	Water[c]	Air[d]		
Strontium-90	800	200	1,000	100	1,000	100
Strontium-89	70,000	20,000	100,000	10,000	100,000	10,000
Cesium-137	1,500,000	200,000	200,000	20,000	200,000	20,000
Barium-140	2,000,000	60,000	300,000	60,000	300,000	60,000
Iodine-131	30,000	3,000	20,000	3,000	20,000	3,000
Radium-226	40	8	100	10	100	10

(a) For 168 hour week for occupational exposure
(b) Announced values pending publication of report
(c) Micromicrocuries per liter
(d) Micromicrocuries per cubic meter

areas which are attributable to operations within the controlled area. Until more specific information is available, it is believed that with the exercise of some judgment similar principles may be applied as guides in application to problems involving exposure of the whole population to radiation.

"The ICRP has made some tentative recommendations relative to whole population exposure. These are designed for long-range planning purposes and in this connection the NCRP considers them to be sound. They are not, however, subject to direct control in the immediate future. In the meantime the NCRP considers that undue risks to the population will not be incurred by following current policies for a while longer, during which time it is hoped that methods may be established for a meaningful analysis and control of population exposure..."

In releasing the report of an Ad Hoc Committee* it was stated,

"... This report" (the Ad Hoc Committee report) "is, therefore, being referred to NCRP subcommittee I on 'Maximum Permissible Dose Criteria' for further consideration and the possible formulation of specific values to be recommended as the maximum permissible dose. Pending the possible formulation and approval of such recommendations, the NCRP recommends the use of the current recommendations of the ICRP concerning permissible doses for the population..."

The International Commission on Radiation Protection (ICRP)

The most limiting recommendations of the International Commission on Radiation Protection are concerned with the exposure of the whole population and are based on the concept of a genetic dose as follows:

*Somatic Radiation Dose for the General Population, Ad Hoc Committee of the National Committee on Radiation Protection and Measurements. Science, Vol. 131, No. 3399, Feb. 19, 1960, p. 482-486.

"... It is suggested that the genetic dose ... to the whole population from all sources additional to the natural background should not exceed 5 rems plus the lowest practicable contribution from medical exposure..."

This applies to the assumed thirty year period of reproductive life. Further, the ICRP states:

"... The Commission does not wish to make any firm recommendations as to the apportionment of the genetic dose of 5 rems but, for guidance, gives the following apportionment as an illustration.

(A)	Occupational exposure	1.0 rem
(B)	Exposure of special groups	0.5 rem
(C)	Exposure of the population at large	2.0 rems
	Reserve	1.5 rems

"... The apportionment of 2.0 rems (with a long-term reserve of 1.5 rems for possible eventualities) for the genetic exposure of the population at large is intended for planning purposes in the development of nuclear energy programs (with the associated waste disposal problems) and more extensive uses of radiation sources. In the case of internal exposure, the radioisotopes of interest are those that contribute to the gonad dose directly (by local concentration) or indirectly (by radiation produced elsewhere in the body). In either case the maximum permissible concentrations in air and water of these isotopes recommended by Committee II for continuous occupational exposure ('168-hour week') are based on an average yearly dose of 5 rems in the gonads or the whole body. If for these isotopes the average concentrations in public air and water supplies are lower than the values recommended for continuous occupational exposure by a factor of 1/100, the genetic dose to the population would amount to 1.5 rems (5 x 1/100 rems/year in the gonads x 30 years = 1.5 rems). In this case the contribution from external sources should be limited to 0.5 rem in order not to exceed the total of 2 rems..."

Concerning somatic dose the ICRP states:

"... No specific recommendations are made at this time as to the maximum permissible 'somatically' relevant dose to the population. However, it is expected that the maximum permissible limits of the individual total doses recommended... will keep the average dose in any tissue at such a level that the injuries that could possibly occur in a population would be well within acceptable limits..."

"In the case of external exposure of the whole body to penetrating radiation the restriction imposed by the genetic dose to the population automatically reduces the doses to internal organs below the individual maximum permissible annual doses recommended... The same thing applies to internal exposure resulting from radioisotopes that directly or indirectly contribute to the gonad dose of a population..."

"There remain for further consideration those isotopes that concentrate in specific organs (other than the gonads). In view of the existing uncertainty as to the dose-effect relationships for somatic effects, it is suggested that for planning purposes the average concentrations of such isotopes, or mixtures thereof, in air or water, applicable to the population at large, should not exceed one-thirtieth of the MPC values for continuous occupational exposure given in the report of Committee II..."

In the ICRP report there is a distinction made between criteria intended for planning purposes in designing atomic energy programs relative to exposures to the average person

in a population (a factor of 1/30 applied to occupational values) versus a maximum dose for individuals in the population at large (a factor of 1/10 applied to occupational values).

In a set of statements clarifying its original recommendations,* the ICRP stated,

> "... The size of a 'group' or a 'population' is a relative concept and it is often difficult to decide whether a group should be considered 'large' and whether relatively small national populations should be referred to as the 'whole' population with respect to exposures of which the importance depends on the size of the group exposed. The size of a group is irrelevant in the case of individual exposure, where groups are defined only to distinguish between individuals for whom the recommended maximum permissible doses are different for various reasons or for whom the membership of a certain group† provides for more specific recommendations with regard to individual monitoring, medical examinations, and surveys of the protection conditions. In the case of, e.g., average exposure, however, the 'whole' population is involved and the responsibility for the interpretation of this concept will rest with national and international administrative authorities responsible for the legal application of protection requirements."

Such deliberations indicate both the statistical nature of evaluating potential biological hazards from relatively low chronic levels of radiation and the necessity of employing value judgments in reaching decisions on radiation protection criteria.

Ad Hoc Committee of the National Committee on Radiation Protection and Measurements

The report of an Ad Hoc Committee of the National Committee on Radiation Protection and Measurements was published in February 1960.‡ This committee clearly stated the necessity of exercising value judgments in reaching decisions on radiation protection.

> "... if a maximum permissible dose is determined, it will necessarily be at an arbitrary level where, in the judgment of those choosing the level, the risk is acceptable as compared to the benefits. Every effort should be made to maintain the actual dose as far below the permissible level as possible..."

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*"Report on Decisions of the 1959 Meeting of the International Commission on Radiological Protection (ICRP)." Radiology. Vol. 74, No. 1, January 1960, p. 116-119.

†Editor's note: The ICRP established the following categories of exposures:

A. Occupational exposure.
B. Exposure of special groups:
   1. Adults who work in the vicinity of controlled areas, but who are not themselves employed on work causing exposure to radiation.
   2. Adults who enter controlled areas occasionally in the course of their duties, but are not regarded as radiation workers.
   3. Members of the public living in the neighborhood of controlled areas.
C. Exposure of the population at large.
D. Medical exposure.

‡Somatic Radiation Dose for the General Population, Ad Hoc Committee of the National Committee on Radiation Protection and Measurements. Science, Vol. 131, No. 3399, Feb. 19, 1960, p. 482-486.

The same committee concluded,

> "... Although it is not our responsibility to determine the exact level, we believe that the population permissible somatic dose from man-made radiations, excluding medical and dental sources, should not be larger than that due to natural background radiation, without a careful examination of the reasons for, and the expected benefits to society from a larger dose..."

The committee also recommended,

> "... that it should be allowable to average doses over a suitably long period of time, e.g. one year, and over population groups approximating the size of a state or major city..."

and

> "... it is recognized that for some radioisotopes, environmental levels may conceivably result in higher radiation doses to children than to adults. In such cases, permissible levels should apply to radiation doses received in the age ranges of highest dose, rather than to the population group as a whole...".

Summary of Statements on Interpretations of Radiation Levels

A complete discussion of establishing radiation exposure standards for the general population is too lengthy and complex to be attempted here. However, a few relevant points may be enumerated.

a. In light of the present day uncertainties of dose-response relationships, especially at low levels of radiation, it may be prudent to assume a linear relationship, i.e., no threshold exists and there is no dependence upon rate of delivery of radiation exposure. This means, among other things that, "... even the smallest dose involves some risk..."* In other words, there is no arbitrary value that may be established below which there is absolute safety and above which there is imminent hazard. Therefore, the establishment of any set of radiation standards must require the exercise of value judgments that are not restricted to technical considerations only, i.e., there must be a balancing of social benefits against biological risks.

b. The basic biological criterion is the amount of radiation exposure over a given period of time to a given organ or organs and for a given segment of the population. The setting of MPC values for radionuclides in water and air is the result of calculations, based on certain assumptions, which would result in this maximum personnel exposure. Criteria applicable to select occupational workers who are under close and constant surveillance, who knowingly and voluntarily accept the potential risks of such

*"Somatic Radiation Dose for the General Population," Ad Hoc Committee of the National Committee on Radiation Protection and Measurements. Science, Vol. 131, No. 3399, Feb. 19, 1960, p. 482-486.

employment and who may leave such employment, may not be directly translatable by a simple conversion factor to the general population consisting of persons of varying ages and status of health who may be unknowingly subjected to some radiation risks and who may have little choice but to live in such an environment.

c. In calculating radiation doses all sources should be considered and the doses therefrom summated, i.e., doses to the whole body are additive for all organs and likewise all doses to a given organ from various isotopes deposited therein are additive. Thus, MPC's for water and air assumes that only one radionuclide is the source of exposure to an organ or organs. If multiple radionuclides are present and/or if external radiation is also present as sources of exposure to an organ or organs then each source must be evaluated on a proportionate prorated basis, i.e., the individual MPC's must be lowered proportionately. Equally correct, standards of MCP's for foods apply to the whole diet. If an individual radionuclide in a single food item is selected for consideration, estimations should be made of its fractional contribution, after due account is made of the contributions or radiation doses from other sources.

d. In dealing with low levels of radiation, it is the average exposure over relatively long periods of time that is important, and transient peaks and valleys in the concentration values of long-lived radioactive materials in the environment may not be critical. Short-lived isotopes, of course, deliver their total energy in proportionately short time. Biological responses may be dose rate dependent, but at relatively low levels of radiation, the principal factor still is though to be the average exposure.

The determination of the degree and nature - type of radionuclides - of environmental contamination (which probably will be ever-changing), the study of movement of radionuclides in the biosphere, the estimations of intake, deposition and retention of radioactive material in the body, the calculation of radiation doses, and the necessary increased basic understandings of doses versus biological effects constitute sets of problems that will hold the attention of scientists in many fields for years to come. More definitive answers to these problems must await the advancement of science on many fronts. In the meantime we must apply our best knowledge concerning radiation and its effects to develop criteria of radiation protection consistent with the benefits to be derived from the use of atomic energy.

Just as a balance must be struck when weighing potential biological risks from radiation versus the benefits, likewise, perspective must be maintained when evaluating the contributions of various sources of radiation exposures to the total exposure, i.e., X-rays, fallout, etc.

With the active studies currently underway by the Federal Radiation Council and with the continuous appraisal of these problems by the NCRP and ICRP, it is anticipated that more definitive statements concerning criteria of radiation exposures other than for the atomic energy worker will be forthcoming. Until such time, the above discussion attempts to provide some background for evaluating the environmental contamination data contained in this report.

SECTION II

MILK

PUBLIC HEALTH SERVICE MILK MONITORING PROGRAM

The U. S. Public Health Service Milk Monitoring Network presently consists of 12 sampling stations. This will be expanded to about 60 stations by the summer of 1960.

The initial purpose of establishing this network was in keeping with the normal and continuing program of the Department of Health, Education, and Welfare to determine trends in our changing environment, including measurement of amounts of radioactivity in water, air, milk, and other foods. Milk was the food chosen for initial testing since it is among the most important elements of the diet and is constantly available at all seasons of the year and in all climates. A primary objective of the project was to develop and simplify methods of collection and radiochemical analysis of milk to make them more suitable for larger scale programs.

The selection of the present 12 sampling stations was based on the following criteria:

1. The milk represented in each sample was from a group of farms milking a total of at least 1,000 cows.

2. The number of individual farms was small enough so that collection of collateral field data from each farm was feasible.

3. The milk samples were from a supply that was part of a metropolitan milkshed.

4. The conditions under which the milk was received were such that each sample was representative of the same farms in the production area.

The Overton, Nevada and St. George, Utah milksheds do not fulfill the 1,000 cow minimum requirement but have been included since they are part of the monitoring program around the Nevada Test Site.

One gallon samples are collected once each month and forwarded by air parcel post to the Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, for radionuclide analysis. It is estimated that these samples represent 2,000 gallon lots. The concentration of

iodine-131, barium-140, and cesium-137 and naturally occurring potassium-40 are all currently being measured when present in the milk by gamma scintillation spectroscopy. Total strontium and strontium-90 are determined following radiochemical separations, and the strontium-90 is calculated by measuring the build-up of the daughter decay product, yttrium-90 (after about a two week wait) using a low background anticoincidence beta counter. The total radioactive strontium is counted in a shielded internal proportional counter with the strontium-90 calculated as the difference.

Publication of the data will normally require a period of about three months after collection due to shipment, processing, decay product build-up, compilation of the data, and inclusion with other radiation data in the monthly reports.

A description of the program appears in "The Occurrence of Strontium-90, Iodine-131 and Other Radionuclides in Milk, May 1957 through April 1958," by J. E. Campbell, G. K. Murthy, A. S. Goldin, H. B. Robinson, C. P. Straub, F. J. Weber, and K. H. Lewis, American Journal of Public Health, Vol. 49, No. 2, Feb. 1959, American Public Health Association, reprinted by the Joint Committee on Atomic Energy Hearings on Fallout from Nuclear Weapons Tests, Vol. 1, May 1959.

Detailed technical descriptions of the methodology of analyses are listed below:

"Determination of I-131, Cs-137 and Ba-140 in Fluid Milk by Gamma Spectroscopy." By G. R. Gagee, G. R. Karches and A. S. Goldin, Public Health Service.

"A Method for the Rapid Ashing of Milk for Radionuclide Analysis," Journal of Dairy Science, 42-1288, Aug. 1959. By G. K. Murthy, J. E. Campbell.

"A Method for the Determination of Radionuclides in Milk Ash," Journal of Dairy Science, 14-1276, Aug. 1959. By G. K. Murthy, L. P. Jarnagin, and A. S. Goldin.

"A Method for the Elimination of Ashing in Strontium-90 Determination of Milk," Journal of Dairy Sciences, 43 (2) 151, Feb. 1960. By G. K. Murthy, J. E. Coakley and J. E. Campbell.

TABLE II. PUBLIC HEALTH SERVICE DATA ON RADIOACTIVITY IN MILK

November 1959

Data from one sampling point supplying the cities listed below

Radioactivity in $\mu\mu c$/liter

Area	Calcium grams/liter		Iodine-131		Strontium-89		Strontium-90		Barium-140		Cesium-137	
	Nov.	Yearly Average	Nov.	Yearly Average	Nov.	Yearly Average	Nov.	Yearly Average	Nov.	Yearly Average	Nov.	Yearly Average
			(a)									
Atlanta, Ga.	1.06	1.18	0	5	0	47	16	15	0	1	40	87
Austin, Tex.	1.05	1.13	0	6	0	26	5	6	0	1	25	49
Chicago, Ill.	1.05	1.10	0	3	0	13	8	8	0	1	40	59
Cincinnati, Ohio	1.15	1.13	0	2	0	22	12	13	0	1	40	52
Fargo, N. D., Moorhead, Minn.	1.02	1.12	0	2	0	19	14	14	0	<1	40	62
New York, N.Y.	1.09	1.08	0	2	0	9	9	9	0	<1	35	55
Overton, Nev. (b)	1.04	1.06	0	<1	0	2	3	3	0	0	15	31
Sacramento, Cal.	1.07	1.11	0	2	0	14	6	5	0	<1	15	46
Salt Lake City, Utah	1.09	1.12	0	3	0	9	5	7	0	<1	35	44
Spokane, Wash.	1.09	1.18	0	6	0	23	12	12	0	1	50	70
St. George, Utah (c)	1.06	1.11	0	1	0	5	3	5	0	0	20	32
St. Louis, Mo.	1.32	1.25	0	3	0	68	24	21	0	3	40	82

(a) Zero means below detectability.
(b) Average includes 9 months - start of the regular monthly collections.
(c) Average includes 8 months - start of the regular monthly collections.

ATOMIC ENERGY COMMISSION DATA ON RADIOACTIVITY IN MILK

Routine milk monitoring is conducted at New York City, Perry, New York, and Mandan, North Dakota, with analyses performed at the Atomic Energy Commission's New York Health and Safety Laboratory. Data for these three locations for the month of October 1959 are presented below. Data for previous months were given in HASL-77, pp. 85-90.*

TABLE III. STRONTIUM-90 AND CALCIUM IN OCTOBER 1959 MILK

Health and Safety Laboratory (HASL) Sampling Locations

	$\mu\mu$c strontium-90 per			Sr^{89}/Sr^{90} at midpoint of sampling month
	liter	kg (powder)	g Ca	
Perry, N.Y. (Powdered whole milk)		97.8 ± 4.2	10.5 ± 0.4	0.6
New York City (Whole liquid milk)	8.09 ± 0.32		8.27 ± 0.32	0.7
Mandan, N.D. (Powdered buttermilk)		233 ± 8	20.9 ± 0.7	0.5
	grams Ca per			
	liter	kg (powder)		
Perry, N.Y. (Powdered whole milk)		9.33		
New York City (Whole liquid milk)	0.98			
Mandan, N.D. (Powdered buttermilk)		11.1		

STATE OF MINNESOTA MILK DATA

Many of the states are rapidly developing programs of radiological health. Minnesota is one of these and has published Radiation Surveillance Studies (Summary report for the period October 1957 to August 1959) by the Minnesota Department of Health, Division of Environmental Sanitation. This report has been transmitted to the U. S. Public Health Service and abstracts of some data are reproduced below. Other states are invited to transmit similar summarized data for possible inclusion in these monthly and quarterly reports.

*Health and Safety Laboratory Strontium Program Quarterly Summary Report, January 1, 1960, available from the Office of Technical Services, Department of Commerce, Washington 25, D. C., for $3.50.

MINNESOTA DEPARTMENT OF HEALTH

Division of Environmental Sanitation

RADIATION SURVEILLANCE STUDIES

Summary Report for the Period

October 1957 to August 1959

"Strontium-90 in Milk

Strontium-90 is considered to be one of the most hazardous materials in fallout for several reasons. First, a relatively large amount of Strontium-90 is produced in the fission reaction; second, it has relatively long radiological half life (i.e., time in which activity is reduced to 1/2 of its initial value) of 28 years; and thirdly, it is chemically similar to calcium, and is metabolized by the body in the same manner as that element. Because of this latter property, the strontium-90 is largely deposited in the bone. Since milk is the main source of calcium in the American diet, it is a general practice to analyze milk for its strontium-90 content as an index of the potential exposure of the population to this element.

"Early findings of studies conducted by the U. S. Public Health Service and the U. S. Atomic Energy Commission indicated that levels of strontium-90 in milk were somewhat higher in the upper midwest than in other parts of the country. Since there were no data on Minnesota milk, and no good way of estimating the levels from other data, a small milk surveillance network was started in September 1958.

"Initially, milk was collected from the prime milk processor in the following locations: Brainerd, Duluth, Faribault, Minneapolis, and Thief River Falls. Subsequently, Rochester replaced Faribault and Worthington was added to the network. At each of these stations, daily (2 ounce) samples are collected and composited, and each month, the composite sample is sent to the department laboratories for analysis. The milk is collected at the bottling machine so that the sample should be randomly representative of the milk produced in that milk shed.

"Table XI shows the average concentrations of strontium-90 in milk by month.

TABLE XI

Strontium-90 in Minnesota Milk
September 1958 - August 1959

Month	Number of Samples	$\mu\mu$c Sr-90/liter milk
Sept.	3	18.9
Oct.	3	12.7
Nov.	5	15.5
Dec.	5	13.3
Jan.	5	15.9
Feb.	5	13.4
Mar.	5	13.5
Apr.	4	12.6
May	4	19.6
June	5	20.7
July	4	14.9
Aug.	4	10.4

"For comparison purposes, the N.C.R.P. recommends a maximum permissible concentration of 100 micromicrocuries of strontium-90 per liter of water, and this figure is generally accepted for milk.* Thus the maximum average level in Minnesota is approximately 20% of the recommended maximum level. The sudden increase in May, 1959 is probably attributable to the fact that around that time the cattle returned to pasture on which a winter's fallout had accumulated. The levels appear to be decreasing in recent months, again probably as a result of the cessation of nuclear weapon tests.

"Throughout the duration of this program, to date, there has been a consistent variation of as much as two fold and more in the concentration of strontium-90 in milk collected at the different sampling points. It would not seem probable that the variation was due to local variations in fallout patterns. Interest in the cause of this variation prompted the department to make a survey of the milk from individual dairy farms in one of the sampling sheds. Again a consistent variation of as much as two has been found between farms within an area of 60 square miles. A detailed study of the entire environment of the cattle in this area is now under progress in an attempt to determine the cause of this fluctuation. The program is being carried on with the cooperation of the University of Minnesota School of Agriculture."

MINNESOTA DEPARTMENT OF HEALTH
SECTION OF PUBLIC HEALTH EDUCATION
UNIVERSITY CAMPUS
MINNEAPOLIS 14, MINNESOTA
FEDERAL 9-7751

February 5, 1960

FOR RELEASE: Saturday, February 6, 1960

SUBJECT: Health Department Reports Latest Findings of Strontium-90 Levels in Milk

Investigations by the Minnesota Department of Health of Strontium-90 levels in milk produced in the state during the six month period from May 1, 1959, to October 31, 1959, reveal an average concentration of 14.3 micromicrocuries per liter in 28 samples taken at six sampling stations.

This level represents only about 14 per cent of the maximum permissible level for lifetime exposure, according to Dr. Robert N. Barr, executive officer of the State Health Department.

The average concentration of Strontium-90 in 35 milk samples collected during the first eight months of this program was 14.4 micromicrocuries per liter, essentially the same concentration as that for the most recent tests. Since June 1959, the concentration of Strontium-90 has steadily decreased. Strontium-90 levels in milk produced in the upper midwest are generally higher than the national averages reported by the U. S. Public Health Service. The latter have shown the same decreasing trend in recent months.

All of the individual samples collected in Minnesota have been well within the permissible maximum of 100 micromicrocuries per liter, a figure set by the National Committee on Radiation Protection and Measurement. The range and average of the readings also compare generally with those reported by the U. S. Public Health Service in recent months.

In September 1958, the average of the state samples was 18.9, compared to the national average of 8.4 micromicrocuries per liter. In April, 1959, the national

*Editor's Note: Please see discussion on "Interpretations of Radiation Levels," page 1.

average reached 9.1, compared to 12.6 in Minnesota. In September, the most recent month for which data is available on both state and national averages, the Minnesota average is 10.6, and the national average is 6.0.

The levels in the 28 milk samples in Minnesota in the period May to October 1959, ranged from a low of 5.4 micromicrocuries per liter to a high of 32.4. Dr. Barr points out that the high reading, taken in June 1959, was still far below the maximum permissible level for lifetime exposure.

A micromicrocurie is the radiation equivalent of one millionth of one millionth of a gram of radium, and a liter is just slightly more than one quart. The units of measurement are the same as those used by the U. S. Public Health Service in its milk surveillance program. Milk samples are now collected at Brainerd, Duluth, Minneapolis, Rochester, Thief River Falls, and Worthington. These sites were selected to give as wide a geographical coverage as possible, as well as to cover the major population areas of the state.

The Minnesota milk tests are part of a program to investigate all aspects of the potential health hazards associated with ionizing radiation sources. Milk was selected for testing because it is probably the principal source in the human diet of Strontium-90, one of the most hazardous to the public health of the radioactive materials. It is extremely difficult to make an exact evaluation of the hazard of a given concentration of radioactive material, such as Strontium-90. At the present state of knowledge, only an estimation of the relative hazard, based on presently accepted standards, is possible.

All levels of Strontium-90 found in milk samples in Minnesota to date have been well within presently accepted maximum permissible concentrations for that isotope. However, from the start of the program there have been consistent variations between levels found at the various sampling locations of as much as two fold at a given time. A more intensive study of the various phases of the environment to find a possible explanation for this phenomenon is now being conducted in the Brainerd milk shed cooperatively by the State Health Department and the Institute of Agriculture of the University of Minnesota. The U. S. Public Health Service has tentatively agreed to support the continuation and expansion of this program in the near future.

Summary Statements on Environmental Sampling Programs

As a service to those concerned directly with the many radiation environmental sampling programs, summary statements will be published as soon as completed showing the organization of these programs. The first of these statements follows dealing with milk monitoring programs. This compilation does not purport to be complete, but does encompass most of the major efforts.

Those in charge of any regularly conducted environmental monitoring programs are encouraged to report both the organizational and administrative aspects of their programs, and the data derived therefrom, for possible inclusion in these monthly reports.

TABLE IV. A SELECTED LIST OF ENVIRONMENTAL SAMPLING NETWORKS FOR ANALYSIS OF RADIOACTIVITY IN MILK*

Type of Sample	Operating Agency	Sponsoring Agency	Where Sampled	No. of Stations	Frequency of Sampling	Year Established
A. Milk	PHS	PHS	U.S.	12*	Monthly	1957
B. Milk	HASL	AEC	U.S.	3	Monthly	1954
C. Dried Milk	Los Alamos Lab.	AEC	U.S. and Foreign (Same as Lamont)	70	Weekly to Quarterly	1956
D. Milk	Minnesota Dept. of Health	Minnesota	Minnesota	6	2 oz. daily Composited Monthly	1958
E. Milk	Geochemical Lab., Lamont Geological Obs., Columbia Univ.	AEC	U.S. and Foreign (Same as Los Alamos)	70	Total 200/year	1954
F. Milk	Consumers Union	Consumers Union	U.S.	50 in '58 26 in '59	Two sets of samples	August 1958
G. Milk	Rad. Prot. Div., Dept. National Health & Welfare	Canada	Canada	16	Monthly	1954
H. Milk	Agricultural Res. Council, Radiological Laboratory	United Kingdom	United Kingdom	34	Monthly	1955

*To be expanded to about 60 by summer, 1960.

TABLE IV (Continued)

Principal in Charge	Gross Radiation	Fission Products	Tracers	Natural Activity	Supplementary Analysis
A. Dr. J. E. Campbell Robt. A. Taft Sanitary Engineering Center Cincinnati, Ohio	Beta	Sr^{89}, Sr^{90} I^{131}, Ba^{140}, Cs^{137}	---	---	Stable Ca
B. Dr. John Harley HASL, AEC	---	Sr^{90}	---	---	Stable Ca
C. Dr. E. C. Anderson LASL, AEC	---	Cs^{137}, Ba^{140}/La^{140}	---	K-40	Stable K
D. Dr. R. N. Barr Secretary and Executive Officer, Minn. State Comm. of Health	---	Sr^{90}	---	---	Stable Ca
E. Dr. A. R. Schulert Lamont Geo. Obs. Columbia U., NYC	---	Sr^{90}	---	---	Stable Ca
F. Consumers Union	---	Sr^{90}	---	---	Stable Ca
G. Dr. P. M. Bird, Rad. Prot. Div., Dept. National Health & Welfare, Canada	---	Sr^{90}	---	---	Stable Ca
H. Dr. R. Scott Russell	---	Sr^{90}	---	---	Stable Ca

MILK NETWORKS

METHODS OF PUBLICATION OF DATA

A. Public Health Service:

PHS Monthly Press Releases

HASL-42 U. S. Atomic Energy Commission, "Environmental Contamination From Weapons Tests," Oct. 1958.

HASL-55 U. S. Atomic Energy Commission, "Strontium Program, Quarterly Summary Report," Feb. 24, 1959.

HASL-65 U. S. Atomic Energy Commission, "Strontium Program, Quarterly Summary Report," May 29, 1959.

HASL-69 U. S. Atomic Energy Commission, "Strontium Program, Quarterly Summary Report," Oct. 1, 1959.

HASL-77 U. S. Atomic Energy Commission, "Strontium Program, Quarterly Summary Report," Jan. 1, 1960.

"Statement on New Data on Uptake on Milk, Food and Bone." Dr. C. P. Straub, PHS, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio. Presented at Joint Committee on Atomic Energy Hearings on Fallout in May 1959, Volume 2, page 963.

The Occurrence of Strontium-90, Iodine-131, and Other Radionuclides in milk, May 1957 through April 1958. American Journal of Public Health, Vol. 49, No. 2, Feb. 1959. Reprinted in Joint Committee on Atomic Energy Hearings on Fallout from Nuclear Weapons Tests, Vol. I, May 1959, pages 186-196.

U. S. Atomic Energy Commission Quarterly Summary Statements on Fallout.

"Report on Radioactivity in Milk (1957-1959)." Dr. C. P. Straub, PHS, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio. Presented at Joint Committee on Atomic Energy Hearings on Fallout in May 1959, Vol. 2, page 197.

B. Health and Safety Laboratory, U. S. Atomic Energy Commission:

HASL-42 "Environmental Contamination From Weapons Tests." Note: A number of Milk Samples from different locations have been analyzed and reported by HASL-42.

HASL-55 AEC Strontium Program Quarterly Summary Reports, Feb. 2, 1959.

HASL-65 AEC Strontium Program Quarterly Summary Reports, May 29, 1959.

HASL-69 AEC Strontium Program Quarterly Summary Reports, Oct. 1, 1959.

HASL-77 AEC Strontium Program Quarterly Summary Reports, Jan. 1, 1960.

AEC Quarterly Summary Statements on Fallout.

AEC Statements at Joint Committee on Atomic Energy Hearings on Fallout. May 1957, Vol. I and II.

"Data on the Strontium-90 Content of Milk and Other Foods During 1958." By Dr. John H. Harley, HASL, AEC, at Joint Committee on Atomic Energy Hearings on Fallout, May 1959, Vol. 2.

C. Los Alamos Scientific Laboratory, U. S. Atomic Energy Commission:

HASL-42 "Environmental Contamination From Weapons Tests," Oct. 1958.

HASL-69 AEC Strontium Program Quarterly Summary Reports, Oct. 1, 1959.

HASL-77 AEC Strontium Program Quarterly Summary Reports, Jan. 1, 1960.

"Radioactivity of People and Foods," by E. C. Anderson, Robert L. Schuch, William R. Fisher, Wright Langham, Science, June 28, 1957.

"Radioactivity of People and Foods." Reprinted in Joint Committee on Atomic Energy Hearings on Fallout, May 1957, Vol. 1.

Dr. Wright Langham, LASL Statement at Joint Committee on Atomic Energy Hearings on Fallout, May 1959, Vol. 2.

AEC Quarterly Summary Statements on Fallout.

"Radioactivity of People and Milk," by E. C. Anderson, Science, Oct. 17, 1958.

"Ba-140 Radioactivity in Foods," by E. C. Anderson, R. L. Schuch, W. R. Fisher, and M. A. Van Dilla, Science, Feb. 7, 1958.

"Cs-137 Biospheric Contamination from Nuclear Weapons Tests," by W. H. Langham and E. C. Anderson, Health Physics 2, 30-48 (1959).

D. Minnesota Milk Network:

Minnesota Health Reports.

E. Lamont Geological Observatory:

Annual Reports.

HASL-42 "Environmental Contamination from Nuclear Tests," Oct. 1958.

Drs. J. L. Kulpand and A. R. Schulert, Statement before Joint Committee on Atomic Energy Hearings on Fallout, May 1957.

Dr. A. R. Schulert, Joint Committee on Atomic Energy Hearings on Fallout, May 1959.

J. L. Kulp, W. R. Eckelmann, and A. R. Schulert, "Strontium-90 in Man," Science, 125, page 219, 1957.

W. R. Eckelmann, J. L. Kulp, A. R. Schulert, "Strontium-90 in Man, II," Science, 127, pages 266-274, 1958.

J. L. Kulp, A. R. Schulert, E. J. Hodges, "Strontium-90 in Man, III," Science, 129, pages 1249-1255, 1959.

J. L. Kulp, R. Slakter, "Current Strontium-90 Level in Diet in United States," Science, July 11, 1958, pages 85-86.

J. L. Kulp, "World-Wide Distribution of Strontium-90 and its Uptake in Man," Bulletin of the Swiss Academy of Medical Sciences, Vol. 14, 1958, pages 419-433.

J. L. Kulp, R. Slakter, A. R. Schulert, "Strontium-90 in Food," Agricultural and Food Chemistry, Vol. 7, July 1959, page 466.

AEC Quarterly Summary Statements on Fallout.

F. Consumers Union:

Consumer Reports, March 1959, "The Milk We Drink." Reprinted in Joint Committee on Atomic Energy Hearings on Fallout, May 1959, Vol. 2.

Consumer Reports, Feb. 1960, "Fallout in Milk."

G. Canadian Milk Network:

"Levels of Strontium-90 in Canada up to May 1956," CRC-791. W. E. Grummitt and E. W. Carruthers.

"Levels of Strontium-90 in Canada up to December 1956," CRC-689. W. E. Grummitt and E. W. Carruthers.

"Levels of Strontium-90 in Canadian Milk Powder Samples up to the End of December 1958," CNHW (RP-Z). P. M. Bird and P. G. Mar. Reprinted in HASL-77, January 1960.

"Preliminary Report on the Measurements of Radioactive Strontium in Canadian Milk Powder Samples." CNHW (RP-1).

"An Intercomparison of Strontium-90 Results from Two Laboratories." CI-204. W. E. Grummitt and E. M. Robertson.

H. United Kingdom Milk Studies:

HASL-42, Atomic Energy Commission, "Environmental Contamination From Weapons Tests," Oct. 1958.

"Strontium-90 in Human Diet in the United Kingdom, 1958 Agricultural Research Council Radiobiological Laboratory Report No. 1, ARCRL-1."

MILK NETWORKS - SAMPLING STATION LOCATIONS

A. Public Health Service Milk Network Stations

Atlanta, Georgia
Austin, Texas
Chicago, Illinois
Cincinnati, Ohio
Fargo, North Dakota - Moorhead, Minnesota
New York, New York
Overton, Nevada
Sacramento, California
Salt Lake City, Utah
Spokane, Washington
St. George, Utah
St. Louis, Missouri

B. Health and Safety Laboratory, Atomic Energy Commission Milk Stations

Perry, New York (Powdered Milk)
New York City, New York (Liquid Milk)
Mandan, North Dakota (Powdered Buttermilk for Animal Feed)

C. Los Alamos Scientific Laboratory, Atomic Energy Commission

(Same dried milk samples processed by Lamont Geological Observatory for Sr-90)

U. S. Stations

Aberdeen, Miss.
Albuquerque, N. Mex.
Andover, Mass.
Bertha, Minn.
Binghamton, New York
Bismarck, N. D.
Bottineau, N. D.
Burlington, Wash.
Chicago, Ill.
Claremont, Minn.
Columbus, Ga.
Deerfield, Wis.
Des Moines, Iowa
Elk City, Okla.
Ellensburg, Wash.
Fernbridge, Calif.
Fort Worth, Texas
Franklinton, La.
Fresno, Calif.
Glendale, Ariz.
Harrisonburg, Va.
Idaho Falls, Idaho
Lancaster, Pa.
Ladysmith, Wis.
LaGrange, Texas
Lansing, Mich.
Little Valley, N. Y.
Louisville, Ky.
Marietta, Ohio
McMinneville, Oreg.
Minonk, Ill.
Monroe, Utah
Newman, Calif.
New Orleans, La.
Norman, Okla.
Ogden, Utah
Payette, Idaho
Pittsburgh, Pa.
Springboro, Pa.
Sibley, Iowa
Springfield, Mo.
St. Albans, Vt.
Stillwater, Minn.
Sunnyside, Wash.
Tipton, Calif.
Wilkesboro, N. C.
Willows, Calif.

Foreign Stations

Buenos Aires, Argentina
Sydney, Australia
Belgium
Brazil
Calgary, Alb., Canada
Chesterville, Ont., Canada
Edmonton, Alb., Canada
Gananoque, Ont., Canada
Granby, Que., Canada
Jarvis, Ont., Canada
Kincardine, Ont., Canada
Saskatoon, Sask, Canada
St. Augustin, Que., Canada
Sussex, N. Bruns., Canada
Winnipeg, Manit., Canada
Santiago, Chile
Bogota, Colombia
Copenhagen, Denmark

Los Alamos Scientific Laboratory (Continued)

Middlesex, England
Paris, France
Frankfurt, Germany
Japan
Liberia
Mexico
Switzerland
Caracas, Venezuela

D. Minnesota Department of Health Milk Network

Brainerd
Duluth
Minneapolis
Rochester
Thief River Falls
Worthington

E. Lamont Geological Observatory Milk Sampling Network

(Same dried milk samples processed by Los Alamos for Cs-137)

U. S. Stations

Aberdeen, Miss.
Albuquerque, N. Mex.
Andover, Mass.
Bertha, Minn.
Binghamton, N.Y.
Bismarck, N.D.
Bottineau, N.D.
Burlington, Wash.
Chicago, Ill.
Claremont, Minn.
Columbus, Ga.
Deerfield, Wis.
Des Moines, Iowa
Elk City, Okla.
Ellensburg, Wash.
Fernbridge, Calif.
Fort Worth, Texas
Franklinton, La.
Fresno, Calif.
Glendale, Ariz.
Harrisonburg, Va.
Idaho Falls, Idaho
Lancaster, Pa.
Ladysmith, Wis.
LaGrange, Tex.
Lansing, Mich.
Little Valley, N.Y.
Louisville, Ky.
Marietta, Ohio
McMinneville, Ore.
Minonk, Ill.
Monroe, Utah
Newman, Calif.
New Orleans, La.
Norman, Okla.
Ogden, Utah
Payette, Idaho
Pittsburgh, Pa.
Springboro, Pa.
Sibley, Iowa
Springfield, Mo.
St. Albans, Vt.
Stillwater, Minn.
Sunnyside, Wash.
Tipton, Calif.
Wilkesboro, N.C.
Willows, Calif.

Lamont Geological Observatory Milk Sampling Network (Continued)

Foreign Stations

Buenos Aires, Argentina	Winnipeg, Manit., Can.
Sydney, Australia	Santiago, Chile
Belgium	Bogota, Colombia
Brazil	Costa Rica
Calgary, Alb., Canada	Copenhagen, Denmark
Chesterville, Ont., Can.	Middlesex, England
Edmonton, Alb., Can.	Paris, France
Gananoque, Ont., Can.	Frankfurt, Germany
Granby, Que., Can.	Japan
Jarvis, Ont., Can.	Liberia
Kincardine, Ont., Canada	Mexico
St. Augustine, Que., Can.	South Africa
Saskatoon, Sask., Can.	Switzerland
Sussex, N. Bruns., Can.	Caracas, Venezuela

F. Consumers Union - July - August 1958

U. S. Stations

Birmingham, Ala.	Chicago, Ill.
Los Angeles, Calif.	Wichita, Kan.
Washington, D. C.	Bangor, Maine
Boise, Idaho	Duluth, Minn.
Des Moines, Iowa	St. Louis, Mo.
New Orleans, La.	Las Vegas, Nev.
Sault Ste. Marie, Mich.	New York, N. Y.
Jackson, Miss.	Cleveland, Ohio
North Platte, Nebr.	Philadelphia, Pa.
Buffalo, N. Y.	Rapid City, S. D.
Bismarck, N. D.	El Paso, Tex.
Portland, Ore.	Seattle, Wash.
Columbia, S. C.	Charleston, W. Va.
Austin, Tex.	Phoenix, Ariz.
Norfolk, Va.	Denver, Colo.
Spokane, Wash.	Atlanta, Ga.
Juneau, Alaska	Indianapolis, Ind.
San Francisco, Calif.	Louisville, Ky.
Miami, Florida	Boston, Mass.

Consumers Union - July - August 1958 (Continued)

Minneapolis, Minn.	Pittsburgh, Pa.
Great Falls, Mont.	Memphis, Tenn.
Santa Fe, N. Mex.	Houston, Tex.
Charlotte, N. C.	Salt Lake City, Utah
Tulsa, Okla.	Casper, Wyoming

Foreign Stations

Quebec, Canada	Winnepeg, Canada

Consumers Union - July - August 1959

U. S. Stations

Little Rock, Arkansas	Jackson, Miss.
San Francisco, Cal.	St. Louis, Mo.
Denver, Colorado	Farmington, N. Mex.
Durango, Colorado	New York, N. Y.
Boise, Idaho	Bismarck, N. D.
Chicago, Ill.	Tulsa, Okla.
Springfield, Ill.	Pittsburgh, Pa.
Des Moines, Iowa	Rapid City, S. D.
Baton Rouge, La.	Memphis, Tenn.
New Orleans, La.	El Paso, Tex.
Boston, Mass.	Norfolk, Va.
Duluth, Minn.	Seattle, Wash.
Minneapolis, Minn.	Madison, Wisc.

Foreign Station

Quebec, Canada

G. Canadian Milk Stations

Vancouver	S	Winnipeg	B	Granby	S	Moncton	B
Edmonton	S	Walkerton	S	Megantic	S	Sussex	S
Calgary	S	London	S	La Durantye	S	East Florenceville	S
Saskatoon	B	Ottawa	S	Chicoutimi	S	Charlottetown	S

S = Skim Milk Powder
B = Buttermilk

H. United Kingdom Milk Network Districts

Cumberland & Westmorland	Bucks & Oxon
Northumberland Durham & Yorks (North & East Riding)	Berks and Hants
Yorks (W. Riding)	Kent, Surrey & Sussex
Cheshire & Lancs	Wilts
Staffs	Dorset
Derby	Somerset
Leics & Notts	Cornwall
Warwicks	Devon
Lincs	Orkney, Ross & Cromarty
Norfolk & Suffolk	Inverness & Moray
Beds, Cambs & Hunts	Aberdeen
Northants	Argyll, Ayr, Dunbarton, Lanark, Renfrew & Stirling
Hereford & Shropshire	Dumfries & Wigtown
Gloucester	Angus, Midlothian, Perth, Roxburgh & Selkirk
Carms & Flamorgan	Co. Antrim, Armagh, Down & Londonderry
Brecknock, Merioneth & Mont	Fermanagh & Tyrone
Anglesey, Caerns & Denbigh	Essex & Herts

SECTION III

AIR

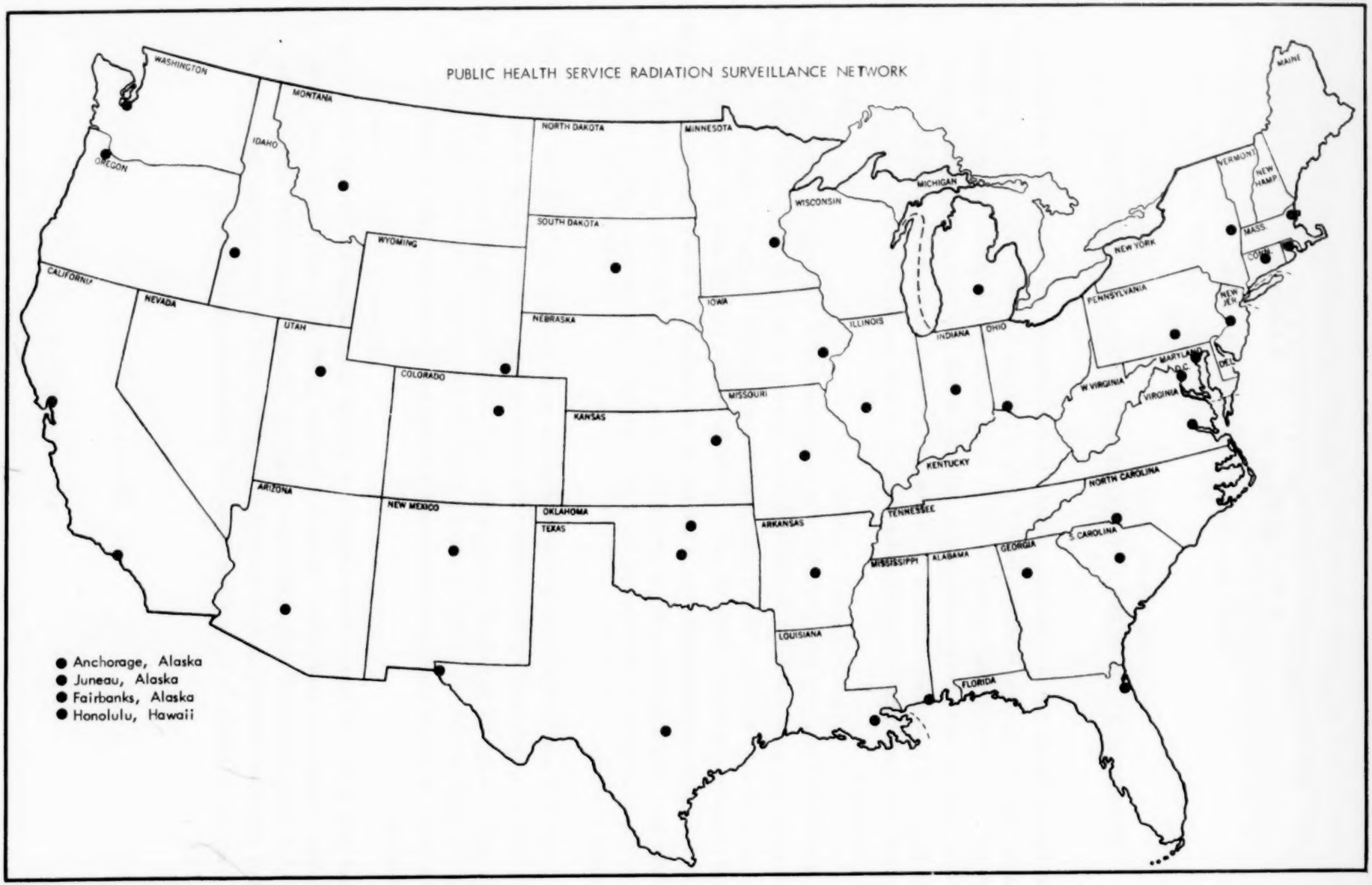
PUBLIC HEALTH SERVICE RADIATION SURVEILLANCE NETWORK

The Public Health Service Radiation Surveillance Network was established in 1956 in cooperation with the Atomic Energy Commission to provide a means of promptly determining increases in environmental radiation due to radioactive fallout during nuclear weapons tests. The program has proven sufficiently valuable that it has been extended to a round-the-year basis and currently consists of 44 stations at urban locations (see figure 1) operated by State and local health department personnel with 3 operated by U. S. Public Health Service personnel.

Measurements of gross beta radioactivity in air have been taken since they provide one of the earliest and most sensitive indications of increases of activity in the environment, and thus act as an "alert" system. These data alone are not conducive to evaluation directly of biological hazards. However, field measurements do enable the operator to estimate the amount of beta activity of particulates in the air at the station five hours after collection, by comparison to a known source, using a portable survey meter. The filters are then forwarded to the laboratory in Washington for a more refined measurement using a thin window proportional counter.

Air samplers are in operation at the 44 stations on an average of 70% of the week. Air is drawn through a cellulose carbon loaded dust filter using a high volume air sampler. The radioactive material in fallout adhering to small dust-like particles is retained on the filter. Some gaseous fission products are adsorbed by the carbon. The contribution by gaseous fission products has represented only a small part of the total beta activity in these samples.

About 85% of the stations collect samples of precipitation which are sent to Washington for analysis. Values are now below limits of detection by present instrumentation. New equipment is being procured to measure lower values. Measurements have indicated that the bulk of deposited activity occurs through precipitation but concentrations in surface air are not directly relatable to the amount deposited through precipitation.



AD-113

FIGURE 1

External gamma measurements are also made at each station (see Section V).

More detailed data from this surveillance network are released monthly by the U. S. Public Health Service. A description of the program is printed in the Hearings on Radioactive Fallout held by the Joint Committee on Atomic Energy in May 1957, Vol. 1, page 459.

TABLE V. PUBLIC HEALTH SERVICE RADIATION SURVEILLANCE NETWORK

Radioactivity of Particulates in Air
Micromicrocuries Per Cubic Meter - Gross Beta Counts
For Month of November 1959

Station Location	Weighted Average	Maximum	Minimum
Alaska, Anchorage	< 0.12	0.31	< 0.10
Alaska, Fairbanks	< 0.12	0.19	< 0.10
Alaska, Juneau	< 0.12	0.28	< 0.10
Arizona, Phoenix	< 0.16	0.23	< 0.10
Arkansas, Little Rock	< 0.12	0.20	< 0.10
California, Berkeley	< 0.18	0.24	< 0.10
California, Los Angeles	< 0.21	0.37	< 0.10
Colorado, Denver	< 0.18	0.29	< 0.10
Connecticut, Hartford	< 0.12	0.27	< 0.10
District of Columbia	< 0.14	0.56	< 0.10
Florida, Jacksonville	< 0.12	0.20	< 0.10
Georgia, Atlanta	< 0.14	0.21	< 0.10
Hawaii, Honolulu	< 0.11	0.17	< 0.10
Idaho, Boise	--	--	--
Illinois, Springfield	< 0.13	0.22	< 0.10
Indiana, Indianapolis	< 0.12	0.20	< 0.10
Iowa, Iowa City	< 0.11	0.20	< 0.10
Kansas, Topeka	< 0.11	0.19	< 0.10
Louisiana, New Orleans	< 0.15	0.19	< 0.10
Maryland, Baltimore	< 0.12	0.24	< 0.10
Massachusetts, Lawrence	< 0.10	0.23	< 0.10
Michigan, Lansing	< 0.11	0.19	< 0.10
Minnesota, Minneapolis	< 0.11	0.21	< 0.10
Mississippi, Pascagoula	< 0.29	0.71	< 0.10
Missouri, Jefferson City	< 0.13	0.24	< 0.10
Montana, Helena	< 0.12	0.16	< 0.10
New Jersey, Trenton	< 0.13	0.27	< 0.10
New Mexico, Santa Fe	< 0.16	0.27	< 0.10
New York, Albany	< 0.11	0.23	< 0.10
North Carolina, Gastonia	< 0.15	0.22	< 0.10
Ohio, Cincinnati*	0.49	2.80	0.20
Oklahoma, Oklahoma City	< 0.15	0.25	< 0.10
Oklahoma, Ponca City	< 0.10	0.13	< 0.10
Oregon, Portland	< 0.16	0.36	< 0.10
Pennsylvania, Harrisburg	< 0.15	0.26	< 0.10
Rhode Island, Providence	< 0.13	0.28	< 0.10
South Carolina, Columbia	< 0.12	0.20	< 0.10
South Dakota, Pierre	< 0.14	0.22	< 0.10
Texas, Austin	< 0.15	0.31	< 0.10
Texas, El Paso	< 0.24	0.68	< 0.10
Utah, Salt Lake City	< 0.17	0.42	< 0.10
Virginia, Richmond	< 0.12	0.19	< 0.10
Washington, Seattle	< 0.15	0.28	< 0.10
Wyoming, Cheyenne	< 0.13	0.18	< 0.10

*See explanation following next table.

TABLE VI. RADON AND THORON AIR MEASUREMENTS

November 2 - 30, 1959
Cincinnati, Ohio

RADIATION SURVEILLANCE NETWORK

(Beta Activity Included)

Date	Continuous Sample Collection			Beta[a] Activity $\mu\mu c/m^3$	Radon[b] AM $\mu\mu c/m^3$	Radon[c] PM $\mu\mu c/m^3$	Thoron[d] $\mu\mu c/m^3$
	Sample Change Time	Sampling Period (Hours)	Volume m^3				
Nov. 2	0804	71.8	73.7	0.4	200	62	2.5
3	0804	23.9	23.7	2.8	733	174	6.3
4	0804	23.9	26.5	0.7	176	72	1.3
5	0806	23.9	28.5	0.3	118	81	0.9
6	0804	23.8	28.1	0.2 (3)	86	92	0.7
9	0810	72.0	83.8	0.5	678	117	3.6
10	0804	23.8	26.3	0.5 (2)	362	122	2.8
11	0806	47.9	53.2	0.5	396	92	2.6
13	0804	23.9	27.3	0.2 (3)	224	93	2.2
16	0810	72.0	81.6	0.2	226	207	1.2
17	0804	23.9	28.5	0.3	135	76	0.8
18	0804	23.9	28.2	0.7	206	96	1.2
19	0804	23.9	28.8	0.7	252	188	1.8
20	0804	23.9	28.2	0.2 (3)	929	210	4.4
23	0804	71.9	83.3	0.8	253	118	4.9
24	0806	23.9	28.2	1.0	424	136	2.3
25	0804	23.8	28.0	0.0 (2)	70	42	0.6
27	0815	48.0	56.4	0.2 (3)	204	91	2.0
30	0804	72.8	85.1	0.2	143	101	1.1
Average				0.5	307	115	2.2

(a) Gross beta activity when counted one day after end of sampling or later as indicated by numeral in parenthesis.

(b) Radon from activity (alpha) of morning filter sample (uncorrected for thoron daughter interference). Measured within a few minutes of removal of filter from sampler and corrected to collection time.

(c) Radon from alpha in the afternoon (3 PM) test after seven hours of sampling. NOTE: Values for PM Radon samples should be compared to the following day AM Radon samples.

(d) Thoron from alpha activity of filter sample counted 7 hours after taking a 24-96 hour sample.

It has been noted recently that values for beta activities in air in Cincinnati are somewhat higher than in other stations in the Radiation Surveillance Network. Reasons may be:

1. Cincinnati uses a membrane type filter with a 20 liters per minute flow rate, compared to a cellulose type filter at other stations sampling 1500 liters per minute.

2. Variations in counting equipment.

3. Samples are counted at Cincinnati within one day after collection, whereas the samples from other stations are counted several days later in Washington. Thus, Cincinnati values may incorporate natural beta activity from thoron daughters.

Although the relative contribution from each of these parameters has yet to be evaluated, it is recognized that some of them probably play a much more significant role than others.

U. S. NAVAL RESEARCH LABORATORY DATA ON RADIOACTIVITY IN AIR

Radioactivity measurements of air-filter samples collected at various sites along the 80th Meridian (west) are made by the U. S. Naval Research Laboratory under a program partially financed by the Atomic Energy Commission.

The daily record of fission product beta activity during November 1959 is shown in Table VII. The radioactivity profile for November 1959 is shown in Figure 2. All radioactivity concentrations are given in disintegrations per minute per cubic meter of air at the collecting site.

The low activity levels presently being encountered throughout this network necessitated that samples from several sites (Porto Alegre, San Juan and Columbia, S. C.) be omitted from radioactivity assay because of insufficient counting capacity.

TABLE VII. U. S. NAVAL RESEARCH LABORATORY DAILY RECORD OF FISSION PRODUCT β-ACTIVITY COLLECTED BY AIR FILTRATION

November 1959

Disintegrations/minute per cubic meter of air						
Day	Punta Arenas	Puerto Montt	Santiago	Antofagasta	Chacaltaya	Huancayo
1	-	T	0.14	0.19	0.15	0.17
2	-	T	0.16	0.19	0.12	0.46
3	-	T	0.19	T	0.15	0.48
4	-	T	0.27	T	0.15	0.17
5	-	T	0.16	T	0.12	0.10
6	-	T	0.14	0.14	T	0.10
7	-	T	0.19	0.14	T	0.10
8	-	T	0.22	0.16	T	T
9	-	T	0.19	0.19	T	T
10	-	T	0.11	0.16	T	T
11	-	T	0.14	0.12	0.15	0.12
12	-	T	0.16	T	0.21	0.10
13	-	T	0.16	0.12	T	0.12
14	-	T	0.14	0.12	T	T
15	-	0.11	T	0.14	T	T
16	-	T	0.16	0.14	T	T
17	-	0.11	0.16	0.14*	0.15	0.15
18	-	T	0.16	0.14*	0.12	0.15
19	-	T	0.19	0.12*	0.15	0.15
20	-	T	0.16	0.12*	T	T
21	-	0.11	0.16	0.14*	T	T
22	-	T	0.24	0.14*	T	T
23	-	T	0.19	0.14*	T	T
24	-	T	-	0.18*	-	0.12
25	-	T	0.16	0.18*	-	0.17
26	-	T	0.16	0.15*	-	0.10
27	-	T	0.11	0.15*	-	T
28	-	T	0.14	-	T	T
29	-	T	0.11	-	T	T
30	-	T	0.16	-	T	0.22
Mean value	-	0.04	0.16	0.13	0.08	0.11

* denotes combined collections
\- not received
T Trace

TABLE VII. U. S. NAVAL RESEARCH LABORATORY DAILY RECORD
OF FISSION PRODUCT β-ACTIVITY
COLLECTED BY AIR FILTRATION
(Continued)

November 1959

Disintegrations/minute per cubic meter of air

Day	Lima	Iquitos	Guayaquil	Quito	Bogota	Miraflores
1	0.16	0.13	0.04*	T	T	T
2	0.16	T	0.04*	T	T	T
3	T	T	0.04*	T	T	0.36
4	0.21	T	T	T	T	T
5	0.16	T	0.11	T	T	T
6	0.13	T	0.11	T	T	T
7	0.11	T	T	T	T	T
8	T	T	0.06*	T	T	T
9	T	T	0.06*	T	T	T
10	0.13	T	T	T	T	T
11	T	T	T	T	T	T
12	T	T	T	T	T	T
13	T	T	T	T	T	T
14	T	T	T	T	0.48	T
15	T	T	T*	T	T	T
16	0.11	T	T*	T	T	T
17	0.11	T	T	T	T	0.11
18	T	-	T	T	T	0.14
19	0.13	-	T	T	T	T
20	T	T	T	T	T	T
21	0.11	T	T	-	T	T
22	0.13	-	0.07*	T	-	T
23	-	-	0.07*	-	-	T
24	-	-	T	T	T	T
25	-	-	0.11	T	T	T
26	-	-	0.13	T	T	T
27	-	0.24	0.13	T	T	0.11*
28	-	T	0.16	T	T	0.11*
29	0.17	-	0.12*	T	T	0.14
30	-	T	0.12*	T	T	0.14
Mean value	0.10	0.04	0.06	0.03	0.05	0.06

* denotes combined collections
\- not received
T Trace

TABLE VII. U. S. NAVAL RESEARCH LABORATORY DAILY RECORD OF FISSION PRODUCT β-ACTIVITY COLLECTED BY AIR FILTRATION
(Continued)

November 1959

Disintegrations/minute per cubic meter of air

Day	Miami	Washington	Bedford	Moosonee	Coral Harbour	Thule
1	0.18	0.30	0.16	0.23	0.16	0.21
2	0.16	0.32	0.25	0.21	0.21	0.16
3	0.23	0.23	0.14	0.16	0.16	0.37
4	0.28	0.35	0.11	0.32	0.13	0.11
5	0.25	0.78	0.58	0.18	0.21	0.11
6	0.16	0.71	0.99	0.28	0.13	0.11
7	0.23	0.23	0.27*	0.21	0.13	0.23
8	0.18	0.23	0.27*	0.37	0.24	0.16
9	0.11	0.32	0.27*	0.35	0.24	0.32
10	0.39	0.41	0.21	0.21	0.16	0.28
11	0.39	0.35	0.27	0.32	0.16	0.35
12	0.11	0.41	0.30	0.23	0.24	-
13	0.11	0.39	0.35	0.14	0.24	0.30
14	0.11	0.39	0.28	0.21	0.29	0.39
15	0.16	0.14	0.18	0.30	0.40	0.28
16	0.21	0.30	0.32	0.35	0.32	0.37
17	T	0.21	0.09	0.23	0.27	-
18	0.11	0.44	0.18	0.30	0.37	0.35
19	T	0.46	0.23	0.35	0.24	0.39
20	0.32	T	0.37	0.37	T	-
21	0.37	0.35	0.28	0.28	0.13	0.41
22	T	0.37	0.23	0.25	0.29	0.64
23	0.09	0.37	0.21	0.23	0.16	0.81
24	0.09	0.48	0.39	0.18	0.11	0.74
25	0.16	0.18	0.23	0.25	0.16	-
26	0.62	0.24*	0.28	T	0.17	-
27	1.06	0.24*	0.21	0.14	0.16	0.41
28	0.55	0.41	0.41	0.14	0.16	0.58
29	0.30	0.16	0.09	0.14	0.21	0.53
30	0.37	0.21	0.16	0.23	0.17	0.21
Mean value	0.25	0.33	0.28	0.24	0.20	0.35

* denotes combined collections
\- not received
T Trace

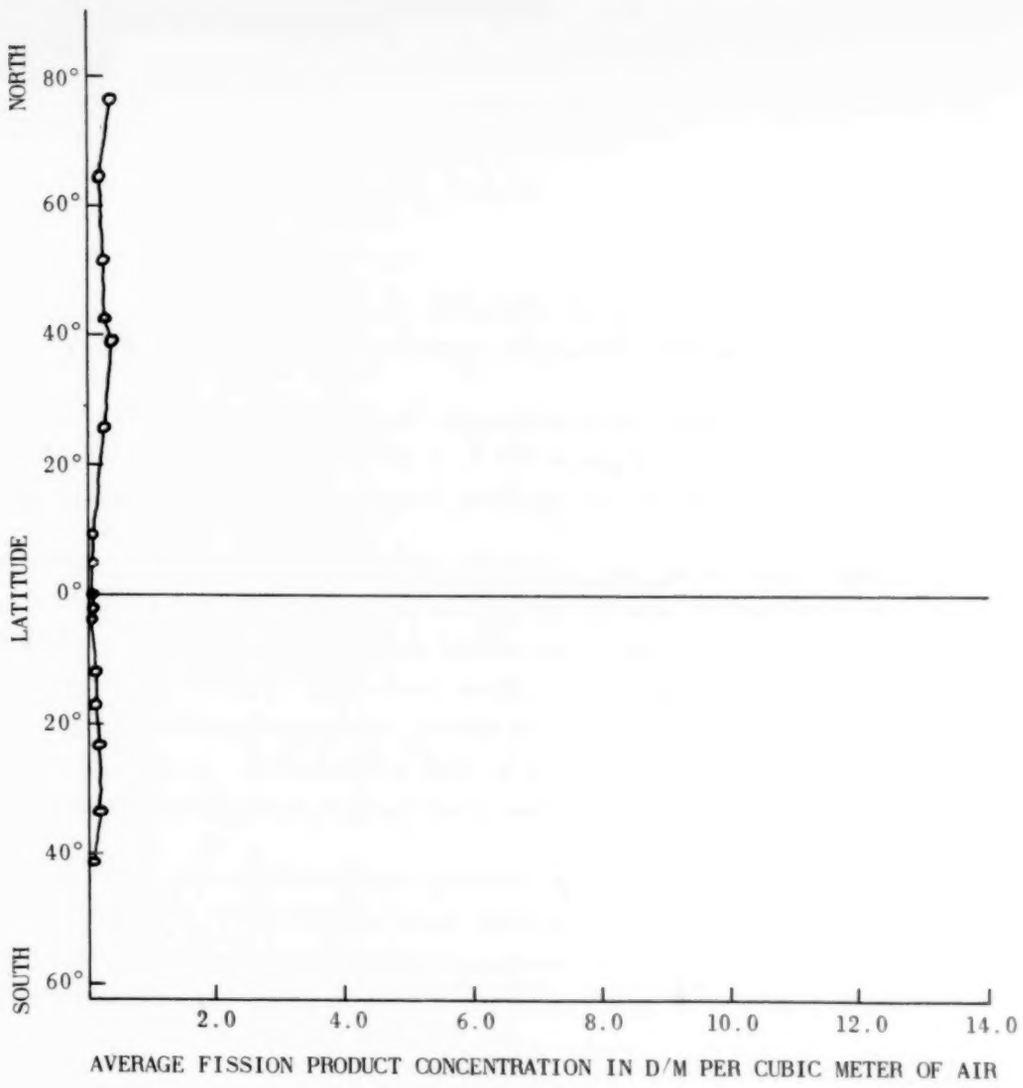


FIGURE 2

RADIOACTIVITY PROFILE FOR NOVEMBER 1959

SECTION IV

WATER

PUBLIC HEALTH SERVICE
NATIONAL WATER QUALITY NETWORK

The National Water Quality Network was established under the provisions of Section 4(c) of Public Law 660, which states that "... the Surgeon General shall ... collect and disseminate basic data ... (relating) to water pollution and the prevention and control thereof."

This Network, operated in cooperation with State and local health agencies, was started in October 1957. At present there are 61 sampling stations located on major waterways used for public water supply, propagation of fish and wildlife, recreational purposes, and for agricultural, industrial and other uses; some of these stations are interstate, coastal, and International Boundary waters, and waters on which activities of the Federal Government may have an impact. Ultimately a total of 250 to 300 stations will be operated. A few of the more recently established stations have not yet begun to report radioactivity.

Samples of water are examined for chemical, physical, and biological quality insofar as these relate to pollution. Samples for some determinations are taken weekly, others monthly, and for some continuous composite samples of 10 to 15 days are obtained. Radioactivity determinations are made on single samples, taken weekly.

Gross alpha and beta measurements are made on both suspended and dissolved solids in the raw surface water samples. The radioactivity levels of dissolved solids provide a rough measure of the levels which may be found in a treated water, where such water treatment removes substantially all of the suspended matter. Naturally occurring radioactive substances in the environment are the source of essentially all of the alpha activity. The contamination of the environment from man-made sources is the major contributor to the beta activity. The results are reported in micromicrocuries per liter, and are shown for each station on a given river.

While beta determinations for the first two years of the Network operation have been done on each sample weekly, the alpha determinations are reported generally on a composite sample of more than one week. Beginning with samples taken in January 1960, beta determinations are to be performed on composite samples obtained by combining two weekly samples. The alpha data will be reported on three-month composite samples, with 1/3 of

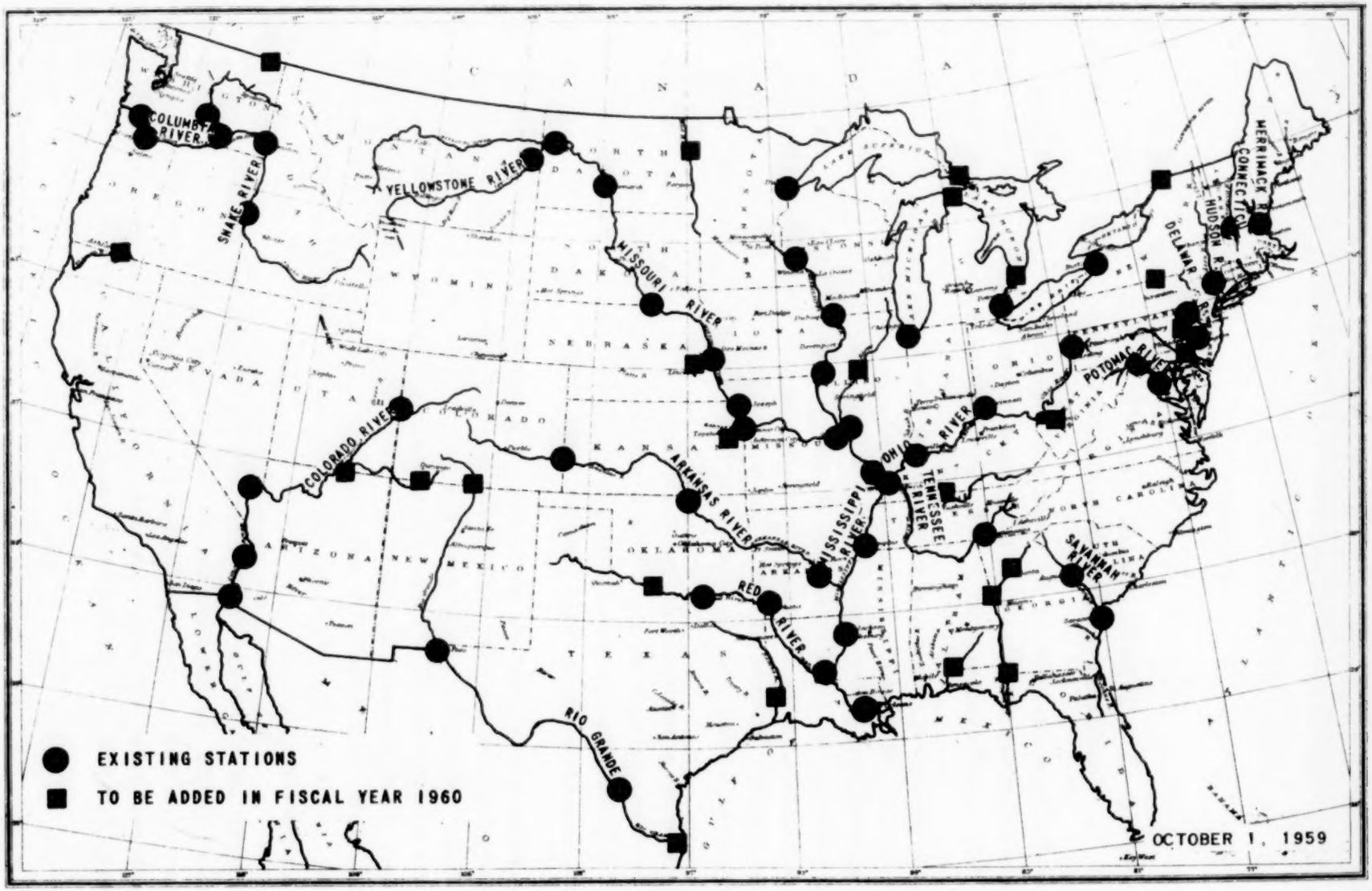


FIGURE 3

PHS WATER QUALITY BASIC DATA PROGRAM NETWORK OF SAMPLING STATIONS

the stations being covered each month. All the data reported below represent the average of all information available for the month indicated.

Strontium-90 data are reported as being the results of determinations on composite sample for a three-month period ending in the month shown.

Additional information and data may be obtained from the following sources:

1. "National Water Quality Network Annual Compilation of Data," PHS Publication. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price $1.50.

2. "Report on National Water Quality Control Network," submitted by Dr. F. J. Weber, Chief, Division of Radiological Health, PHS, to Joint Committee on Atomic Energy Hearings on Fallout from Nuclear Weapons Tests, Vol. 1, May 1959, Pages 167-169.

TABLE VIII. PUBLIC HEALTH SERVICE NATIONAL WATER QUALITY NETWORK
RADIOACTIVITY IN RAW SURFACE WATERS
(Micromicrocuries per liter)

Station	Quarter ending Sept. 30, 1959	Month of October 1959 (Average to nearest whole number)					
	Strontium-90	Beta Activity			Alpha Activity		
		Susp.	Dis.	Tot.	Susp.	Dis.	Tot.
ALSEA RIVER							
Alsea, Ore.	0.2	<1	1	2	0	0	0
ARKANSAS RIVER							
Coolidge, Kans.	1.4	<1	19	19	4	30	34
Ponca City, Okla.	0.5	18	20	38	18	1	19
Fort Smith, Ark.	2.1	98	8	106	19	0	19
Pendleton Ferry, Ark.	0.3	86	9	95	30	0	30
CHATTAHOOCHIE RIVER							
Columbus, Ga.	-	<1	5	5	0	0	0
COLORADO RIVER							
Loma, Colo.	0.3	14	16	30	8	4	12
Hoover Dam, Ariz.-Nev.	0.9	4	30	34	<1	8	9
Parker Dam, Ariz.-Calif.	0.6	0	6	6	0	6	6
Yuma, Ariz.	0.8	<1	2	2	<1	5	6
COLUMBIA RIVER							
Wenatchee, Wash.	0.4	1	4	4	0	0	0
Pasco, Wash.	1.0	25	445	470	0	0	0
Bonneville Dam, Ore.	0.5	22	280	302	0	0	0
Clatskanie, Ore.	0.5	15	139	154	0	1	1

TABLE VIII. PUBLIC HEALTH SERVICE NATIONAL WATER QUALITY NETWORK
RADIOACTIVITY IN RAW SURFACE WATERS
(Micromicrocuries per liter)
(Continued)

Station	Quarter ending Sept. 30, 1959	Month of October 1959 (Average to nearest whole number)					
	Strontium-90	Beta Activity			Alpha Activity		
		Susp.	Dis.	Tot.	Susp.	Dis.	Tot.
CONNECTICUT RIVER							
Northfield, Mass.	1.9	-	-	-	-	-	-
DELAWARE RIVER							
Philadelphia, Pa.	0.6	4	4	8	0	0	0
GREAT LAKES							
Gary, Ind.	0.4	3	2	5	0	1	1
Duluth, Minn.	0.2	1	4	5	0	1	1
Detroit, Mich.	0.6	4	3	7	0	0	0
Buffalo, N. Y.	0.8	28	1	29	0	1	1
HUDSON RIVER							
Poughkeepsie, N. Y.	1.0	<1	6	7	0	1	1
MERRIMACK RIVER							
Lowell, Mass.	1.2	15	6	21	-	-	-
MISSISSIPPI RIVER							
Red Wing, Minn.	0.5	2	2	4	0	2	2
Dubuque, Iowa	1.6	<1	11	11	-	-	-
Burlington, Iowa	1.1	17	9	26	2	2	4
East St. Louis, Ill.	1.2	5	2	7	16	2	18
Cape Girardeau, Mo.	1.2	39	7	46	16	4	20
West Memphis, Ark.	1.3	17	10	27	-	-	-
Delta, La.	1.3	36	6	42	7	0	7
New Orleans, La.	1.0	5	9	14	13	1	14
MISSOURI RIVER							
Williston, N. D.	0.5	6	2	8	2	4	6
Bismarck, N. D.	0.8	26	7	33	19	4	23
Yankton, S. D.	0.4	2	8	10	-	-	-
Omaha, Nebr.	1.1	12	22	34	4	4	8
St. Joseph, Mo.	0.6	26	5	31	7	3	10
Kansas City, Kans.	0.3	15	14	29	6	11	17
St. Louis, Mo.	0.5	26	10	36	12	2	14
OHIO RIVER							
East Liverpool, O.	1.2	6	10	16	0	0	0
Huntington, W. Va.	1.0	8	18	26	1	1	2
Cincinnati, O.	0.9	0	<1	<1	0	0	0
Evansville, Ind.	2.0	-	-	-	-	-	-
Cairo, Ill.	1.2	1	6	7	0	1	1

TABLE VIII. PUBLIC HEALTH SERVICE NATIONAL WATER QUALITY NETWORK
RADIOACTIVITY IN RAW SURFACE WATERS
(Micromicrocuries per liter)
(Continued)

Station	Quarter ending Sept. 30, 1959	Month of October 1959 (Average to nearest whole number)					
	Strontium-90	Beta Activity			Alpha Activity		
		Susp.	Dis.	Tot.	Susp.	Dis.	Tot.
POTOMAC RIVER							
Williamsport, Md.	0.7	4	7	11	0	1	1
Great Falls, Md.	0.8	1	5	6	0	0	0
RED RIVER							
Denison, Tex.	1.0	3	4	7	0	3	3
Index, Ark.	0.6	14	2	16	1	7	8
Alexandria, La.	0.4	30	0	30	7	0	7
RIO GRANDE RIVER							
El Paso, Tex.	0.3	0	10	10	-	-	-
Laredo, Tex.	0.2	67	3	70	0	1	1
Brownsville, Tex.	-	6	35	41	2	9	11
SAVANNAH RIVER							
North Augusta, S. C.	0.3	2	5	7	-	-	-
Port Wentworth, Ga.	0.7	20	12	32	0	0	0
SNAKE RIVER							
Wawawai, Wash.	0.4	3	10	13	0	1	1
TENNESSEE RIVER							
Chattanooga, Tenn.	3.8	3	5	8	0	0	0
YELLOWSTONE RIVER							
Sidney, Mont.	0.7	14	10	24	0	0	0

MONITORING OF WATER SUPPLIES AROUND THE NEVADA TEST SITE

By contract with the Atomic Energy Commission the U. S. Public Health Service has conducted an off-site monitoring program around the Nevada Test Site for several years. Included in the program have been measurements of radioactivity in water supplies. These data have been reported in the Atomic Energy Commission's 13th, 14th, 18th and 23rd Semiannual Reports to Congress and by the Public Health Service in the 1957 Congressional Hearings, "The Nature of Radioactive Fallout and Its Effects on Man."

The map following summarizes the data on radioactivity (gross beta) in water supplies for the months of November and December 1959. The lower limit of detectability with the equipment used is about 10^{-8} microcuries per milliliter (10 micromicrocuries per liter).

HEALTH AND SAFETY LABORATORY - ATOMIC ENERGY COMMISSION STRONTIUM-90 IN NEW YORK CITY TAP WATER

New York City tap water is monitored for strontium-90 on a monthly basis by the Atomic Energy Commission's New York Health and Safety Laboratory. The strontium-90 in tap water for September 1959 is presented below. Data for other months in 1959 were given in HASL-77, p. 68.*

HASL #	Total volume collected liters	$\mu\mu$c Sr^{90}/liter	Sr^{89}/Sr^{90} a midpoint of sampling month
11363	225	0.78 ± 0.01	0.8

STATE OF MINNESOTA WATER DATA

The following is reproduced from Radiation Surveillance Studies (Summary report for the period October 1957 to August 1959) by the Minnesota Department of Health, Division of Environmental Sanitation. Other states are invited to transmit similar summarized data for possible inclusion in these monthly and quarterly reports.

"Activity in Ground and Surface Water

The analysis of various Minnesota waters for radioactivity concentrations was initiated late in 1956, as part of the Minnesota Water Pollution Control Program.

*Health and Safety Laboratory Strontium Program Quarterly Summary Report, January 1, 1960, available from the Office of Technical Services, Department of Commerce, Washington 25, D.C., for $3.50.

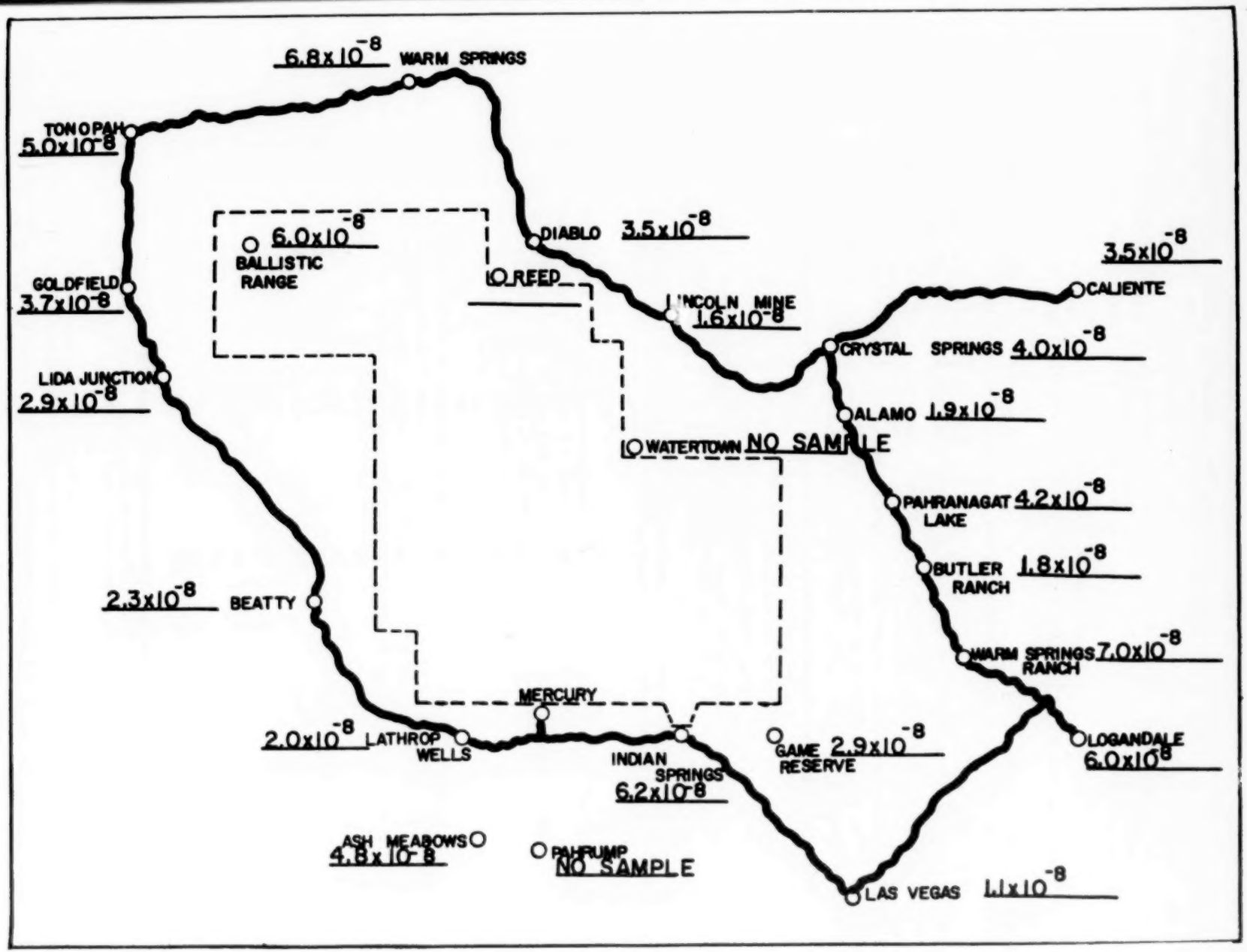


FIGURE 4

GROSS BETA MEASUREMENTS IN WATER SUPPLIES IN OFF-SITE AREAS OF THE NEVADA TEST SITE FOR NOVEMBER-DECEMBER 1959 (μc/ml at count time)

This program was expanded in 1958 to include most of the surface municipal water supplies in the state as well as a representative number of ground water supplies and selected lakes throughout the state. In the period from late 1956 to August 1959, various water samples from 74 stations on 25 streams were collected and analyzed. The program was gradually modified and as of July 1959 routine collections of samples were being made at the following locations:

20 Stream Stations
8 Supplemental Lake Stations
16 Surface Water Municipal Supplies
20 Ground Water Supplies

Grab samples were collected monthly at each station, with the exception of the Minneapolis, St. Paul, and Duluth stations, where weekly samples were collected.

"The data obtained on radioactivity in Minnesota river waters shows a very random variation of gross levels, with no significant trends. Variations in precipitation, flow rates, and point of collection could all contribute to this non-uniformity. The range of values of river water gross beta radioactivity levels is from 431 micromicrocuries per liter to levels indistinguishable from background. The great majority of values are less than 100 $\mu\mu$c/l., the maximum permissible concentrations for water consumed on a continuous basis.*

"The more recent data on river water are summarized in Table V.

TABLE V

River Water Radioactivity Summary
Average Gross Beta Activity $\mu\mu$c/L.
October 1957 through July 1959

Month	Year	Northern* Region	Central** Region	Southern*** Region	Entire State	No. of Samples
Oct.	1957	169	62	67	99	37
Nov.		45	34	35	40	34
Dec.			25	26	26	46
Jan.	1958	25	16	22	21	48
Feb.			15	34	24	15
Mar.		77	42	38	52	27
Apr.			27	50	38	44
May		68	34	38	47	21
June		68	48	63	60	33
July		138	145	75	116	23
Aug.		60	99	75	78	20
Sept.		59	45	48	51	23
Oct.		51	60	72	61	37
Nov.		68	97	69	78	30
Dec.		74	36	39	50	24
Jan.	1959	28	34	26	29	22
Feb.		39	16	25	27	29
Mar.		36	16	59	40	31
Apr.		57	30	54	48	29
May		60	50	29	67	26
June		52	36	51	47	31
July		36	31	34	32	19

* Red River, Rainy River and Lake Superior Drainage Basins
** Upper Mississippi and Saint Croix River Drainage Basins
*** Minnesota, Lower Mississippi, Missouri and Des Moines River Drainage Basins

* Editor's note: Please see discussion on "Interpretations of Radiation Levels," p. 1. The gross beta activities in waters during these time periods were essentially all from mixed fission products in radioactive fallout, only a small fraction of which was strontium-90. Other radioisotopes in mixed fission products are relatively less hazardous than strontium-90 and thus have higher maximum permissible concentrations.

"As pointed out above, samples have been collected routinely at 16 municipal surface water supplies. Samples of the raw water and the treated water were collected at each of these points and analyzed for gross beta activity. Data from this program are available on samples collected up to August 1, 1959. The levels in the raw-water samples through the data range from levels indistinguishable from background to 222 micromicrocuries per liter, with an average value of 41 $\mu\mu$c/l. The levels found on the treated water ranged from those indistinguishable from background to 130 $\mu\mu$c/l., with an average value of 20 $\mu\mu$c/l. These figures would indicate that water treatment plants have removed, on the average, a little more than 50 percent of the radioactivity from raw water. The efficiency of removal varies widely, depending on the age of the fission products and the type of treatment involved.

"A routine collection of samples from 8 of the major lake types in Minnesota was initiated in 1958. Monthly grab samples were collected and analyzed for gross beta radioactivity. Levels found through 1959 ranged from those indistinguishable from background to 286 micromicrocuries per liter. The average value is 30 micromicrocuries per liter.

"Samples have been collected from 20 municipal well water supplies. The wells were selected to give a good cross section of the levels of activity which exist in the water supplies in the various geological formations which serve as water sources to some part of the Minnesota population. Samples were collected from wells drawing water from river deposits, glacial draft deposits, springs, deep sedimentary rock, Sioux quartzite, and mine drainage. The levels of beta activity ranged from levels indistinguishable from background to 170 micromicrocuries per liter and the average value was 16 micromicrocuries per liter. The levels of alpha activity ranged from those indistinguishable from background to 110 micromicrocuries per liter, and the average value was 8 micromicrocuries per liter. Tables VI through IX include the complete data on these four sampling programs.*

"It is somewhat difficult to ascertain any meaningful trends in these data, beyond a general conclusion that the levels in all surface water samples have been generally decreasing in the last several months. This is undoubtedly due to the cessation of weapons testing by all the nuclear powers. There does not appear to be real cause for concern at present over the levels of radioactivity in municipal drinking water supplies.

"Although the threat of contamination from weapons fallout appears to be diminishing, the expected rise in the use of reactors for power in the future may present problems very similar to those of fallout. The experience gained during the operation of the large water sampling program will be invaluable in meeting these problems."

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*Editor's note: Because of their length, Tables VI through IX are not included here. Please refer to the basic document.

SECTION V

OTHER DATA

EXTERNAL GAMMA ACTIVITY
PUBLIC HEALTH SERVICE RADIATION SURVEILLANCE NETWORK

Portable survey instruments are available at the stations of the Radiation Surveillance Network and one of their uses is to record external gamma radiation. These readings are not precise, especially for measurement of low levels but they can show the presence or absence of any significant increases above background. The differences among the values shown on the following table are within the variances anticipated due to differences in normal background and in instrument response characteristics.

TABLE IX. EXTERNAL GAMMA ACTIVITY
PUBLIC HEALTH SERVICE RADIATION SURVEILLANCE NETWORK
Milliroentgens Per Hour - at three feet above the ground
For Month of November 1959

Station Location	Average
Alaska, Anchorage	0.011
Alaska, Fairbanks	0.010
Alaska, Juneau	0.015
Arizona, Phoenix	0.012
Arkansas, Little Rock	0.020
California, Berkeley	0.010
California, Los Angeles	0.012
Colorado, Denver	0.020
Connecticut, Hartford	0.013
District of Columbia	0.020
Florida, Jacksonville	0.020
Georgia, Atlanta	0.020
Hawaii, Honolulu	0.025
Idaho, Boise	*
Illinois, Springfield	*
Indiana, Indianapolis	0.011
Iowa, Iowa City	0.013
Kansas, Topeka	0.020
Louisiana, New Orleans	0.011
Maryland, Baltimore	0.015
Massachusetts, Lawrence	0.015
Michigan, Lansing	0.020

Station Location	Average
Minnesota, Minneapolis	0.020
Mississippi, Pascagoula	*
Missouri, Jefferson City	0.010
Montana, Helena	0.024
New Jersey, Trenton	0.020
New Mexico, Santa Fe	0.030
New York, Albany	0.020
North Carolina, Gastonia	0.020
Ohio, Cincinnati	*
Oklahoma, Oklahoma City	0.020
Oklahoma, Ponca City	0.040
Oregon, Portland	0.019
Pennsylvania, Harrisburg	*
Rhode Island, Providence	0.019
South Carolina, Columbia	0.018
South Dakota, Pierre	0.020
Texas, Austin	0.010
Texas, El Paso	0.019
Utah, Salt Lake City	0.015
Virginia, Richmond	0.010
Washington, Seattle	0.015
Wyoming, Cheyenne	0.020

*No data received this month.

TABLE X. FISSION PRODUCT RADIOACTIVITY IN SOIL
AT ARGONNE NATIONAL LABORATORY - ATOMIC ENERGY COMMISSION
(In millicuries per square mile*)

Isotope	1959			
	August	September	October	November
Zr^{95}-Nb^{95}	592	444	366	264
Cs^{137}	159	172	201	186
Ru^{106} (1 y)	855	1003	969	996
Ru^{103} (40 d)	53	30	--	--
Ce^{141} (32 d)	74	48	--	--
Ce^{144} (290 d)	1706	1774	1924	1846
Totals	4031	3915	3826	3556
Dose (urad/hr)**	5.33	4.49	4.00	3.33

* Reported to the Atomic Energy Commission by Dr. Philip F. Gustafson, Argonne National Laboratory.

** Editor's note: These calculated values are based on the theoretical considerations that if all of these radioisotopes found in depth within the soil were placed in an infinitely flat plane, then the indicated dose rates would result at a height of three feet above that plane.

MINNESOTA DEPARTMENT OF HEALTH
DIVISION OF ENVIRONMENTAL SANITATION
RADIATION SURVEILLANCE STUDIES

From Summary Report for the Period October 1957 to August 1959

"Activity in Fish

"In February, 1958 at the request of the Department of Conservation, a study of the levels of radioactivity in game fish was initiated jointly by the Department of Health and the Division of Game and Fish Department of Conservation. Four Minnesota fisheries stations were selected to collect the samples on a monthly basis. Samples were shipped to the Health Department Laboratories for analysis. Initially the level of gross beta radioactivity only was determined, but when equipment and satisfactory methods were available, the samples were also analyzed for strontium-90.

"In the period from February, 1958 through July, 1959, 31 samples were analyzed for strontium-90. The average level in these samples was 131 $\mu\mu$c Sr-90/kg, which is above the generally used maximum permissible concentration of 100 $\mu\mu$c Sr-90/kg for foodstuffs.* Six of these samples were divided into

* Editor's note: Please see discussion on "Interpretation of Radiation Levels," page 1.

waste, bones, skin, and flesh, and these four parts were analyzed individually. In four of the fish specimens, the average concentration in all flesh, or edible portions, was 12 $\mu\mu$c Sr-90/kg, or slightly more than 10 percent of the recommended maximum permissible level. Two of the flesh samples were not run due to error in method made during the early phase of the study.

"The complete details of the study are contained in a report from the Department of Health to the Department of Conservation titled, Levels of Strontium-90 in Minnesota Fish. The report draws the following conclusion from the study, 'The results of this study indicate that in the light of present knowledge no immediate health hazard from the effects of strontium-90 exists from the consumption of Minnesota fish.' "

URANIUM MILL DISCHARGES

The problem of radioactive pollution of the Animas River (Colorado-New Mexico) from the discharge of a uranium mill was surveyed in 1958. The following agencies cooperated with the U. S. Public Health Service in this study:

U. S. Atomic Energy Commission
State of Colorado Department of Public Health
New Mexico Department of Public Health
State of Colorado Department of Game and Fish
San Juan Basin Health Unit, Durango, Colorado
San Juan County Health Department, Farmington, New Mexico
U. S. Geological Survey
Vanadium Corporation of America

The survey included a wide variety of environmental samples such as river waters, treated water supplies, local milk and food, and effluents from the uranium ore refineries. Radium and uranium content of the samples were measured, as well as the gross alpha and beta activities. Many chemical analyses were also performed.

The table below indicates the radium content in water supplies before (1958) corrective actions were taken by the mill and afterwards (1959). In addition, the irrigation waters used to raise crops locally have also improved proportionately in terms of their radium content, and thus lower radium concentrations in crops are anticipated. Based upon further actions now being taken by the mill, it is estimated that the dissolved radium content of these water supplies will be routinely no greater than 1.00 micromicrocuries per liter.

TABLE XI. RADIUM CONTENT OF WATER SUPPLIES

Station and Item	Dissolved Radium, $\mu\mu$c/liter		
	1958	1959	Approximate % Decrease
Aztec, New Mexico			
Raw Water	3.4	1.4	60
Treated Water	3.6*	1.15	68
Farmington, New Mexico			
Raw Water	2.8	1.25	56
Treated Water	2.6	1.40	46

* Residual contamination of the filter sands in the treatment plants resulted in a higher level of dissolved radium for treated water than for raw river waters.

REFERENCES

1. Survey of Interstate Pollution of the Animas River, Colorado-New Mexico, Tsivoglou, E. C., Shearer, S. D., Shaw, R. M., Jr., Jones, J. D., Anderson, J. B., Sponagle, C. E., and Clark, D. A. U. S. Public Health Service report, May 1959.

2. Survey Interstate Pollution of the Animas River, Colorado-New Mexico, II 1959 Surveys. Tsivoglou, E. C., Shearer, S. D., Jones, J. D., Sponagle, C. E., Pahren, H. R., Anderson, J. B., and Clark, D. A. U. S. Public Health Service report, January 1960.